VARIATION IN *PETRADORIA PUMILA* (ASTERACEAE: ASTEREAE)

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ABSTRACT

Populations of *Petradoria pumila* with linear-filiform leaf blades, primarily in Arizona and northwestern New Mexico, are treated as *P. pumila* var. *graminea*. They are interpreted here to be distinctive variants at the southern extremity of a north-south cline with the gradient breaking sharply at the southern end. Formal taxonomic recognition can be maintained for var. *graminea*, although intermediates are common and the taxon probably is artificial, especially if enclaves of linear-filiform variant populations in central Utah are identified as var. *graminea*. Clusters of populations from Clark, Nye, White Pine, and Elko cos., Nevada, along the western margin of the geographic range, differ from others of the species (var. *pumila* and var. *graminea*) in disc floret number. In these populations (9 populations, 15 plants), disc florets per head range 5–10, averaging 7.0. Over the rest of the range of the species (n = 125 plants, outside of Nevada), disc florets range 2–4(–5), averaging 3.3. There is no evidence that the high floret number populations in Nevada represent a single lineage.

RESUMEN

Las poblaciones de *Petradoria pumila* con láminas foliares linear-filiformes, de Arizona y noroeste de Nuevo México, se tratan como *P. pumila* var. *graminea*. Aquí se interpretan como variantes diferenciables del extremo Sur de una variación clinal Norte-Sur con el gradiente que se rompe netamente en el extremo Sur. Se puede mantener el reconocimiento taxonómico formal de la var. *graminea*, aunque los intermedios son comunes y probablemente el taxon es artificial, especialmente si los enclaves con poblaciones variantes linear-filiformes en Utah central se identifican como var. *graminea*. Los grupos de poblaciones de Clark, Nye, White Pine, y Elko cos., Nevada, a lo largo del borde Oeste de su areal geográfico, difieren de otros de la misma especie (var. *pumila* y var. *graminea*) en el número de flósculos del disco. En estas poblaciones (9 poblaciones, 15 plantas), los flósculos del disco por capítulo varían de 5–10, con una media de 7.0. En el resto del areal de la especie (las plantas n = 125, fuera de Nevada), los flósculos del disco varían de 2–4(–5), con una media de 3.3. No hay pruebas de que las poblaciones con alto número de flósculos en Nevada representen una línea simple.

The genus *Petradoria* Nutt. was treated by Anderson (1963) to include two species: *P. pumila* (Nutt.) Greene and *P. discoidea* L.C. Anderson (= *Chrysothamnus gramineus* H.M Hall). He later reinstated *P. discoidea* within *Chrysothamnus* (Anderson 1983), but molecular evidence subsequently has shown that species to be phylogenetically remote from both *Chrysothamnus* and *Petradoria* (Beck et al. 2004; Roberts & Urbatsch 2004). *Chrysothamnus gramineus* has now been segregated as the monotypic genus *Cuniculotinus* Urbatsch et al. (Urbatsch et al. 2005), and *Petradoria* has reverted to its monotypic status (Urbatsch et al. 2006). *Petradoria pumila* is morphologically distinct from *Stenotus* Nutt., its closest relative, in having many, few-flowered heads with vertically aligned phyllaries, functionally staminate disc florets, and glabrous cypselae.

Petradoria pumila is a common plant of pine forests, pinyon-juniper woodlands, and shrub communities in the southwestern U.S.A. The distribution is centered around Utah and includes northern Arizona, San Bernardino Co., California, western Colorado, southeasternmost Idaho, northwestern New Mexico, Sweetwater Co., Wyoming, and eastern Nevada (Fig. 1). A single collection from the "Truckee Mts."cited and mapped by Anderson (1963) as originating from Washoe Co., Nevada (2 May 1868, *S. Watson* 557, [US]) is out of range for the species. Two other 1868 collections by Watson, however, both numbered "557," have locality data placing them in Elko Co., Nevada. It is probable that the specimen with the "Truckee Mt." label also was collected in Elko Co.

In Anderson's monograph, largely followed by Urbatsch et al. (2006), *Petradoria pumila* comprises two infraspecific taxa (treated as subspecies by Anderson, as varieties by subsequent authors): var. *pumila* occurs over most of the range; var. *graminea* (Woot. & Standl.) S.L. Welsh is mostly restricted to the southernmost portion of the range. Urbatsch et al. (2006) distinguished the two taxa by the following contrasts:

1. Leaves usually 1(–3)-nerved, 1–2 mm wide; involucres 1.3–2 mm wide; ray florets usually 1, laminae 0.7–1.5 mm wide; disc florets 2–3 _____ var. **graminea**

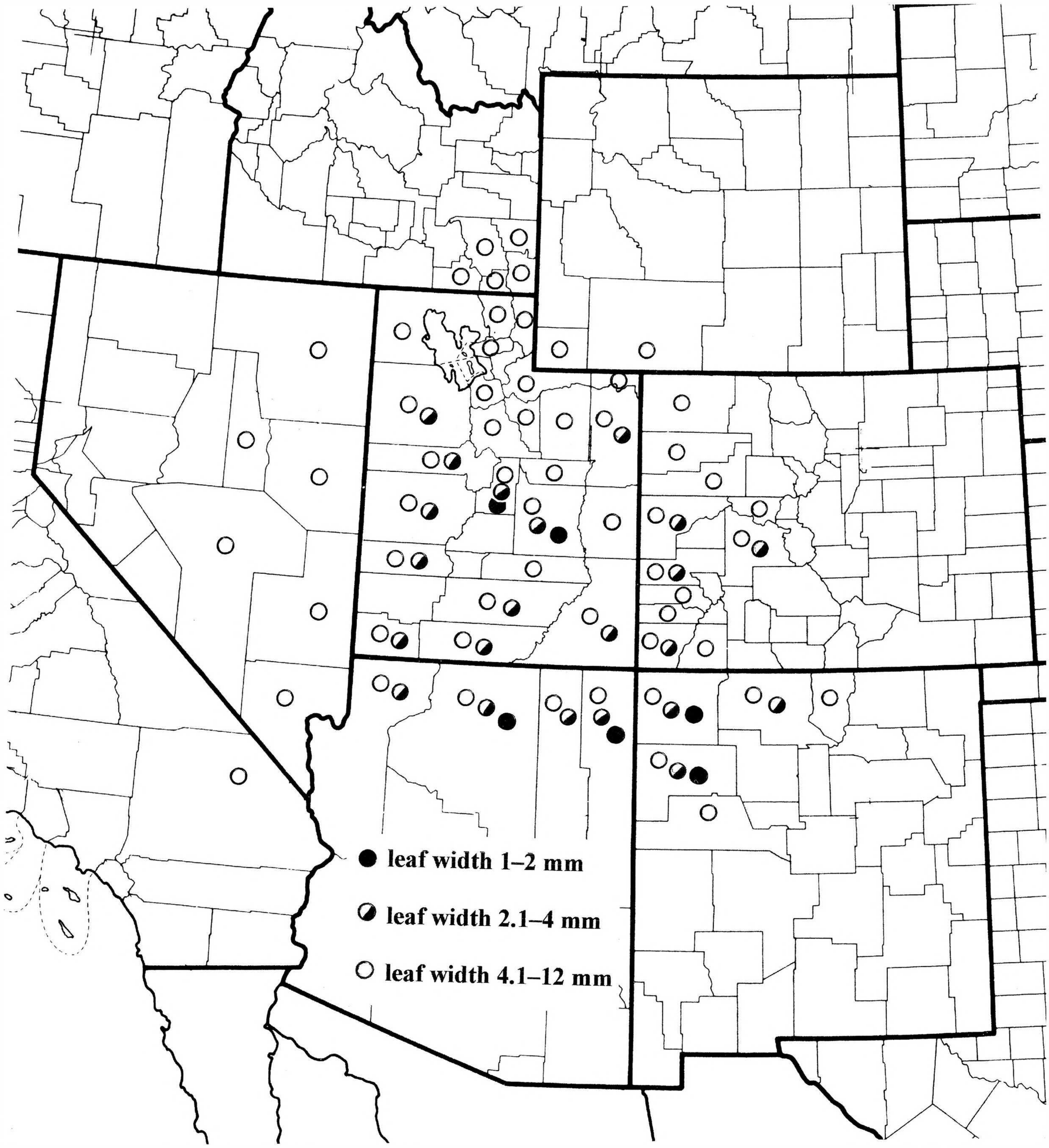

Fig. 1. Variation in leaf shape in *Petradoria pumila*. Linear-leaved plants (var. *graminea*) are concentrated mostly in the southernmost portion of the range but they also appear in more northern localities. The typical form occurs throughout the range of the species.

1. Leaves usually 3–5-nerved, 2–12 mm wide; involucres 1.9–3 mm wide; ray florets usually (1–)2–3, laminae 1–2.4 mm wide; disc florets 2–4(–5) _____ var. **pumila**

The present study reexamines taxonomically significant characters. Our observations generally agree that linear-leaved variants are concentrated in Arizona and New Mexico although evidence suggests that they do not represent a single lineage. We also document previously unrecognized variability in disc floret number.

Leaf morphology and other clinal variation

As cited and mapped by Anderson (1963), var. *graminea* occurs in Mohave, Coconino, and Apache cos.,

Arizona, and San Juan and McKinley cos., New Mexico. Using his criteria for identification, we add Navajo Co., Arizona, and Sanpete and Emery cos., Utah, to the distribution of var. *graminea*. Welsh et al. (2003, p. 218) also noted that "a few specimens from Emery and Garfield counties seem to be clearly allied to var. *graminea*." A county-level map of collections showing intermediate-width leaves (Fig. 1), however, suggests that variation in leaf width (and number of veins, which is correlated) is continuous, if intermediates between var. *pumila* and var. *graminea* are considered to have leaves 2.1–4 mm wide. Linear-leaved plants tend to be concentrated in southern populations but plants of typical morphology and intermediates are common in the same region. Disjunct enclaves of linear-leaved plants (var. *graminea*) in central Utah are hardly distinguishable from southern linear-leaved plants, and it seems likely that populations with linear leaves have arisen independently.

Anderson (1963) observed that var. *pumila* occurs at higher elevations where it occurs sympatrically with var. *graminea*. We are not able to test this, but our data suggest that there is no overall distinction in elevation: 20 collections from Arizona in our study referable to var. *graminea* occur at a range of 5000–8500 ft, averaging 7020 ft; 46 collections from Arizona referable to var. *pumila* or intermediates between the two varieties occur at an elevational range of 4600–8500 ft, averaging 6350 ft. Plants of var. *pumila* have been collected at a range of (4000–)5000–8300(–10,000) ft in Utah, Colorado, and New Mexico. *Petradoria pumila* in San Bernadino Co. (and one collection from Tulare Co.), California, occurs at 3500–7000 ft.

Anderson (1963, p. 681) noted with respect to var. *pumila* that "much of its variation is clinal along the north-south axis of its range," these trends illustrated in his figs. 44 and 45. Figure 1 of the present study indicates that a similar clinal trend is reflected in leaf width. Figure 2 indicates that there are no discontinuities in leaf width in each of four areas within the range of the species.

Anderson's Figure 45 shows geographic variation in involucral width, ray width and number, and disc floret number—measurements for each of these features decrease in a north-to-south direction. Fig. 44 shows geographic variation in the number of involucral bracts per head; number of bracts slightly increases southward in var. *pumila* (overall range 10–21) but bract number in plants identified as var. *graminea* ranges 11–15. We did not make a detailed analysis of involucral bract number, but whatever differences may exist do not appear to be significant. We counted 20 bracts in several plants from northern Utah.

In summary, the linear-leaved plants may justifiably be treated without formal rank, since it seems likely that many of the populations are independently derived, especially if those in Utah are identified as var. *graminea*. But a final clinal step in reduction of leaf width gives these plants a distinctive appearance, and they are concentrated at the southern extremity of the range of the species. The name var. *graminea* is available for those who wish to use it, although the taxon probably is largely artificial.

Floret number

Over the range of the species, excluding Nevada, we confirm that numbers of florets per head are essentially as reported for the species by Anderson (1963): ray florets 1–3, disc florets 2–4(–5). We also note that heads completely lacking ray florets occur at a low frequency, sometimes on plants with rayed heads. In counts from a total of 125 collections from all states in the range except Nevada, ray florets per head range (0–)1–2(–3, rarely), while disc florets range (1–)2–4(–5). For these same populations, ray florets average 1.4, while disc florets average 3.3. The modal number of ray florets per head is 1 in Colorado, New Mexico, Utah, and Arizona. Number of ray florets does not distinguish var. *graminea*.

In contrast to the normal situation, in a series of populations along the western extremity of the range in Nevada (Fig. 3; 9 collections, 15 plants), disc florets per head range 5–10, averaging 7.0. Ray florets per head range 1–3, as elsewhere in the range. In most other Nevada localities (38 collections, 66 plants), disc florets per head range (1–)3–5, averaging 3.8. Except for slightly broader involucres, the higher-number plants differ in no other apparent features from the lower-number ones.

Cited here are collections mapped with high numbers of disc florets. Floret numbers are in square brackets [ray,disc]; multiple plants are separated by a backslash. **NEVADA. Clark Co.:** Charleston Mts., Lee Canyon, 8000 ft, 28 Jul 1913, *Heller 11015* [2,8/2,6] (DS, MO, NY, UC, US); Charleston Mts., near Griffith Peak, *Windham 97-117* [2,7] (MO). **Elko Co.:** Angel Lake, ca. 13 km SW of Wells, 2600 m, *Lowry*

	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7
ARIZ (n=27)	8	5	5	4	2	2	1	0					
NMEX (n=30)	1	4	9	6	4	2	3	0					
UTAH (SnJn Co.) (n=33)		0	3	2	3	5	4	2	3	3	6	2	0
IDA-NEV (n=30)			0	2	1	4	3	7	5	3	4	1	1

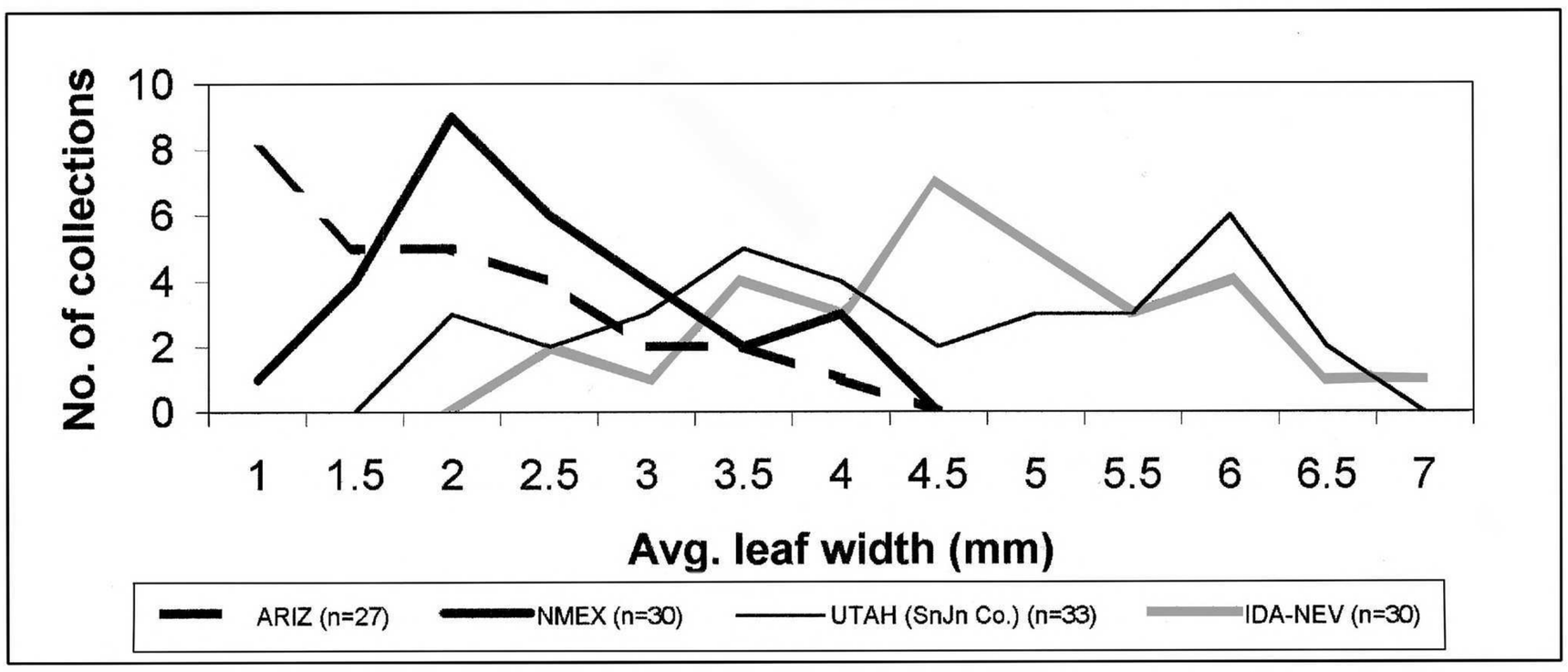

Fig. 2. Variation in leaf width in *Petradoria pumila*. Data points represent average width of basal leaves, one measurement per sheet, with some duplicate sheets measured. Arizona (4 counties), New Mexico (5 counties), Utah (San Juan Co.), and Idaho and Nevada (8 counties).

4630 [2,7] (MO); Ruby Mts, N slope of Verdi Peak, 9000 ft, 13 Aug 1941, *Mills & Beach 1543* [3,6/2,5/3,5] (BRIT, UC). **Nye Co.:** between Haystack Canyon and Mosquito Creek, 8800 ft, 22 Jul 1984, *Atwood et al. 10516a* [3,9/3,8] (BRY, NY); S flank of Mt. Jefferson, SE side of Toquima Range, 10,000 ft, 2 Aug 1976, *Williams 76-95-7* [1,6/3,5] (CAS, NY, UTC). **White Pine Co.:** Snake Range, W of Baker, ridge E of Lehman Creek, 10 Aug 1963, *Breedlove 5821* [1,7] (SMU); summit of Cave Mt., 16 mi due E of Ely, 18 Jul 1997, *Hess et al. 7624* [1,9/2,7] (BRIT, MO); Schell Creek Range, ca 1 mi S of Success Summit on NV Rte 486, 8600 ft, 16 Jul 1981, *Pinzl 4406* [2,10] (MO).

In the Charleston Mountains of Clark Co. and a few other localities, considerable variation in disc floret number per head apparently occurs within some populations. Studies of population structure in the Charleston Mountains and in the Snake Range might reveal whether such variation actually occurs continuously within populations or whether sampling by collectors included plants from adjacent, genetically different populations. From the Prospect Ridge area of Eureka Co., other collections have been only of plants with low floret numbers. Cited below are vouchers for collections with duplicates and multiple plants in which counts of disc florets per head (1 count per plant) are in both low and high ranges. Clark Co.: Charleston Mts., ridge S of Deer Creek, 2700 m, 31 Jul 1935, *Clokey & Clokey 5644* [1,7/2,6/2,6/2,6/2,5/3,4/2,4/2,4/2,4/1,4/2,3] (LL, MO, RM, RSA, TEX); Charleston Mts., gravelly wash with juniper and pine, 2270 m, 12 Jul 1936, *Clokey 7345* [2,6/1,6/1,5/2,3] (MO, TEX, UC). Eureka Co.: Prospect Ridge, SW part of county, on Relay Station Rd, 8700 ft, 19 Jul 1983, *Williams & Tiehm 83-108-4* [2,8/1,5] (NY). White Pine Co.: Snake Range, Mt. Washington, S slope at head of canyon, 10400 ft, 14 Aug 1964, *Holmgren & Reveal 1657* [1,6/2,4/1,4] (NY, TEX).

Vestiture variants

Plants of one population from the Clover Mountains of Lincoln Co., Nevada, produce densely hirsutulous-puberulent stems and leaves (*Tiehm & Crisafulli 11415* [BRY, CAS, COLO, NY, ORE, RM, RSA, TEX]). Otherwise, these specimens are similar to specimens referable to var. *pumila*, which mostly are completely glabrous. Plants of another population from Lincoln Co. ("Deer Lodge," *Train 2521* [MO, UC]) have very sparsely hirsutulous leaves. Other plants from scattered localities in the range also produce a sparsely hirsutulous indument, *e.g.*, Coconino Co., Arizona (*Clover 4320* [TEX]; *Parker 6188* [LL]); Emery Co. (*Hatch s.n.* [UTC]), Garfield Co. (*Richards 14962* [GH, UTC]; *Foster 5399*, BRY]), and Millard Co. (*Brooks 20353* [KANU, RM]; *Cottam 5660* [LL]), Utah.

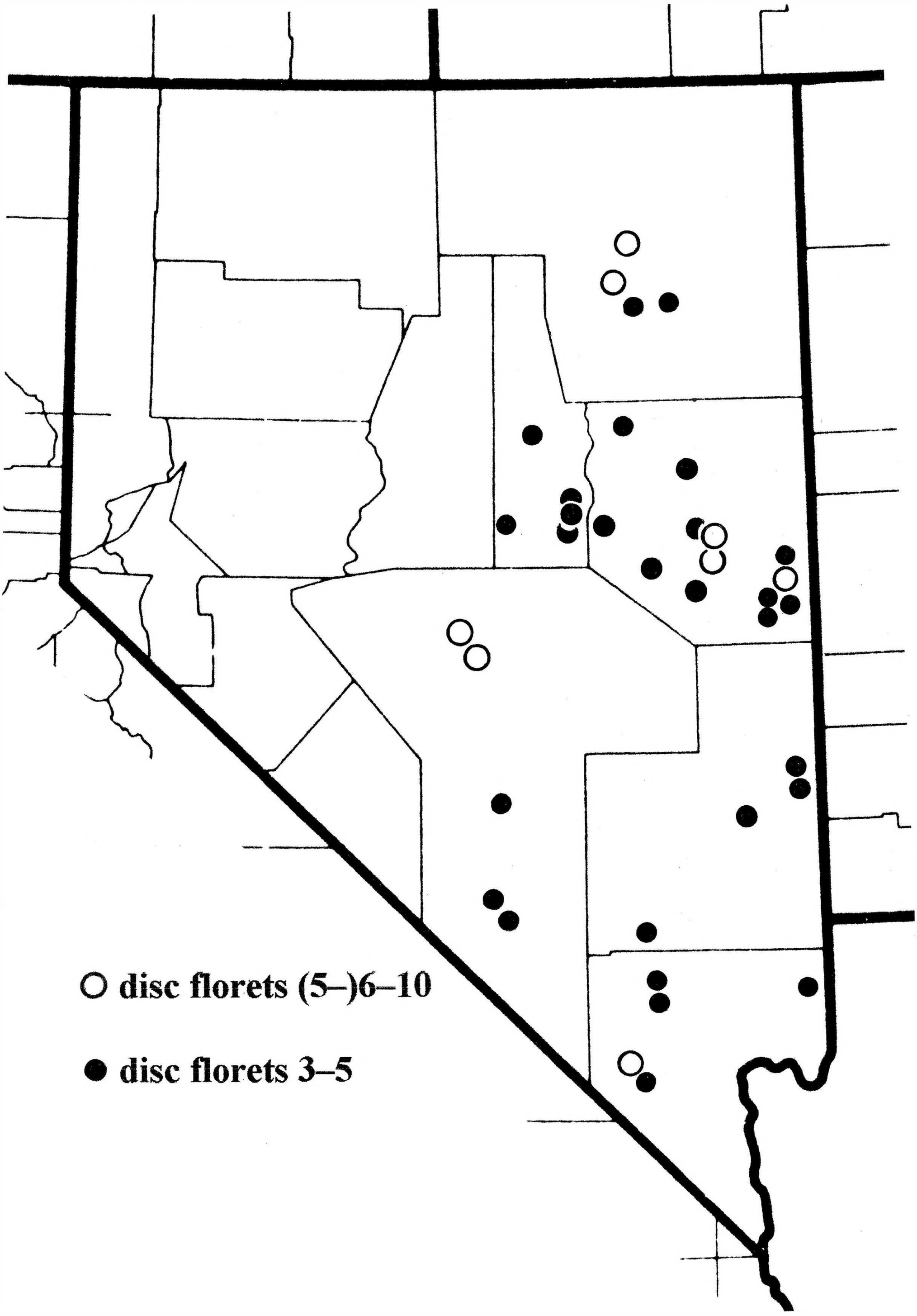

FIG. 3. Distribution of *Petradoria pumila* in Nevada. Plants with high numbers of disc florets per head occur in clusters along the western boundary of the species.

Chromosome number

Diploids and tetraploids have been reported within *Petradoria pumila* (Anderson 1963). Diploids are from Arizona, Nevada, and Utah; tetraploids are from Kane Co., Utah, and Coconino Co., Arizona. No morphological differences between diploids and tetraploids were reported by Anderson, nor do we observe any.

Taxonomy

Petradoria pumila var. **pumila**

Petradoria pumila (Nutt.) Greene, Erythea 3:13. 1895. *Chrysoma pumila* Nutt., Trans. Amer. Philos. Soc., n.s. 7:325. 1840. TYPE: U.S.A. [IDAHO. Bear Lake Co.:] "In open situations, on shelving rocks toward the western declivity of the Rocky Mountains" [protologue], 1834, *T. Nuttall s.n.* (HOLOTYPE: BM!, photo-US!). In June of 1834, Wyeth's expedition (with Nuttall as naturalist) was in Sweetwater Co., Wyoming, but slightly north of the known localities for *P. pumila*. After crossing the Green River, they continued to Ham's Fork in Lincoln Co., Wyoming (Graustein 1967). Leaving Ham's Fork in early July, they traveled northwestward into Bear Lake Co., Idaho, and continued toward Soda Springs in Caribou Co., where they stopped from 8–10 July. Because the leaf morphology of the type specimen is closely matched in recent collections from Bear Lake Co., we believe that Nuttall collected the type there, at the northernmost point of the range of the species, apparently the only place where he would have encountered it. Anderson (1963) also concluded that the type collection was made in "southeastern Idaho." In the description, Nuttall noted "Discal florets three; rays usually two."

Petradoria pumila var. *petiolaris* A. Nels., Bull. Torrey Bot. Club 26:482. 1899. TYPE: U.S.A. WYOMING. Sweetwater Co.: North Vermilion Creek, southern portion of the county, abundant on stony hillsides, growing with typical forms of the species, 17 Jul 1897, *A. Nelson 3581* (HOLOTYPE: RM!; ISOTYPES: BM!, BRY!, COLO!, GH!, MO!, NY!, UTC!). In the protologue, Nelson noted that "The narrow leaves and their much greater relative length give the variety a very different aspect, but I think the difference can hardly be considered specific." The MO isotype has 2 ray and 5 disc florets.

Petradoria pumila var. **graminea** (Woot. & Standl.) S.L. Welsh, Great Basin Naturalist 43:324. 1983. *Solidago graminea* (Woot. & Standl.) Blake, J. Washington Acad. Sci. 21:326. 1931. *Petradoria pumila subsp. graminea* (Woot. & Standl.) L.C. Anderson, Trans. Kansas Acad. Sci. 66:682. 1964. *Petradoria graminea* Woot. & Standl., Contr. U.S. Natl. Herb. 16:183. 1913. TYPE: U.S.A. NEW MEXICO: "N. Mexico" [as on label], "northwestern New Mexico" [in protologue], 14 Jul 1883, *C.C. Marsh 209* (HOLOTYPE: US!, internet image, photo-UC!). The type presumably was collected either in San Juan Co. or McKinley Co., New Mexico.

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